

CHEESE AND ITS MANUFACTURE.

UNIVERSITY OF NEVADA.

Agricultural Experiment Station.

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Agricultural Experiment Station.

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Reno, Washoe County, Nevada.

Please acknowledge receipt of this Bulletin.

CHEESE AND ITS MANUFACTURE.

N. E. WILSON.

Dairying is no longer an experiment in this State. The industry is firmly established and is destined to become one of the leading occupations of our people.

Nevada butter is unsurpassed in quality, and there is no reason why we can not make an equally good cheese. Cheese making is a most important part of the dairying industry, and one which yields a good revenue, especially when made in connection with butter.

The favorable manner in which Bulletin No. 16—"The Creamery Industry"—was received has led to the publication of the following outline of cheese and its manufacture.

THE CHEMISTRY OF CHEESE MAKING.

The curd of milk is the material of which cheese is made. This consists principally of casein, a nitrogenous substance resembling greatly in composition the albumen of the egg, fibrin of flesh and blood, gluten of various grains as wheat and oats, and legumine of peas, beans and other leguminous or pod-bearing plants.

Like these substances casein is colorless, odorless, insoluble in water and alcohol, soluble in alkaline solutions, and coagulated or curdled in such solutions by the addition of acids which neutralize the alkalinity. It ferments very readily, emitting a most disagreeable odor, and breaks up with the formation of several acids and ammonia.

Milk contains quite a proportion of free soda, which, being alkaline,

holds the casein in solution. Thus fresh milk is a thin homogenous mixture. If, however, an acid be added to milk this free soda is neutralized and the casein is at once coagulated (or precipitated).

Upon standing an acid (lactic acid) is formed in milk from the decomposition of the milk sugar. This acid acts upon the free soda present and neutralizes it. Thus coagulation of the casein takes place and the milk separates into two parts—a solid, the precipitated casein or curd, and a liquid known as whey.

Upon these properties of milk and its constituents is based the process of cheese manufacture. In making cheese the milk is not allowed to stand until it becomes sour, but is curdled by the addition of some substance which causes the casein to coagulate.

Any acid will bring about this effect, and in the manufacture of some kinds of cheese, vinegar, tartaric acid, muriatic acid, lemon juice and cream of tartar have been used.

The usual method of coagulating the casein is by the use of rennet. This substance is prepared from the stomach of a sucking calf. Being made from the stomach it naturally contains considerable of the digestive fluids contained therein, and it would seem that it may act as a true digestive function upon the milk constituents, causing the coagulation of the curd.

As soon as the curd is set acidification of the whey takes place, caused by the continued decomposition of the milk sugar and the consequent formation of lactic acid. As some whey is necessarily left in the cheese there is present the "leaven of fermentation," which is the basis of the process known as "ripening." This is one of the most critical points in the art of cheese manufacture, and must be watched with great care, for if allowed to go too far, complete decomposition and subsequent putrefaction would result. To obviate this, as well as to give taste and flavor to the cheese, salt is used, which, by its antiseptic properties retards the process of fermentation. This should be added to the curds cold. If a rapid ripening is desired the least possible amount of salt should be used. If, however, one prefers a slow curing larger quantities should be used.

Temperature is an active chemical agent, and acts energetically in the curing of cheese. High temperature produces rapid ripening, while a low temperature retards ripening by controlling the chemical changes taking place in the cheese.

The presence of fungus growths, such as the bluish green mould (*Penicillium crustaceum*), so abundant on old cheese and bread which

have been kept in damp places, affect the character of cheese, and while they may be turned to good use in the curing process they are generally to be guarded against.

QUALITY OF CHEESE.

The richness of cheese depends very much upon the amount of butter fat which it contains. Cheese may be made from clear cream, from whole milk, from unskimmed milk to which cream has been added, from partially skimmed milk, from milk completely skimmed, or from butter-milk.

Straight skim cheese, however, is practically unsalable, and the general practice in using skimmed milk is to introduce "neutral" or highly refined lard to take the place of the fat removed in the cream. Such cheese properly made can be sold at about 10 to 12 per cent. below the figures which full milk cheese brings. This practice is rather questionable unless the cheese is plainly branded "Filled Cheese," and in many eastern States is prohibited by law. While great quantities of skim cheese are made in this country it cannot be bought, so rapid is its metamorphosis into "full cream cheese"—a most remarkable change.

The curdling agent acts only upon the casein and not upon the fat particles, which are imbedded in the curd thus adding only to the flavor and richness of the cheese. To the casein alone is due the consistency of the cheese. A full cream cheese, therefore, has not the firmness and consistency of a whole milk cheese. On the other hand a skim milk cheese is too tough and lacks flavor and richness. The finest cheese is made from full milk, or milk to which some extra cream has been added.

VARIETIES OF CHEESE.

The varieties of cheese are almost infinite in number. The general principles involved are the same in all, the actual difference being due to minute details in manufacture and the difference in shape and size.

COMPOSITION OF CHEESE.

Cheese is composed of varying proportions of water, fat, casein, acid (lactic), and mineral ash, which is principally from the salt used in its manufacture. An analysis of samples of the several qualities is given below.

	Water.	Fat.	Casein.	Acid.	Ash.
Full milk, cream added	30.53	41.58	23.38	2.45	2.06
Full milk.....	31.70	36.18	27.19	1.95	2.98
Skim milk.....	43.82	5.98	45.04	3.12	2.06

YIELD OF CHEESE.

The yield of cheese depends upon the quality of the milk and the care with which the manipulation is carried on. On the average, all conditions being favorable, 100 pounds of normal milk will make from nine to eleven or twelve pounds of completed cheese.

PRICE OF CHEESE AND MARKET.

Mr. J. H. Hegler of San Francisco, who so kindly supplied me with the data for "Price of Butter and Market," which appeared in Bulletin No. 16 of this Station, has furnished the following figures relative to Price and number of pounds of best cheese received by them for the past four years. A fair idea of the cheese market may be obtained from their perusal.

	1888	1889.	1890.	1891	Average monthly price.	Total pounds received.
January.. .. .	{Price	13	12½	14½	14	764,425
	{Pounds received	103,250	293,875	165,875		
February	{Price	16½	11	14	13 62½	836,125
	{Pounds received	125,375	247,125	202,125		
March	{Price	17	10	11½	12 50	1,193,750
	{Pounds received	243,845	356,500	245,750		
April... .. .	{Price	13½	9½	11	10 75	1,617,375
	{Pounds received	359,125	409,950	395,200		
May..... .. .	{Price	12	10	9	9 87½	1,907,000
	{Pounds received	412,500	610,750	452,500		
June	{Price	11	8	8½	8 87½	1,272,250
	{Pounds received	278,250	390,125	322,500		
July.. .. .	{Price	12	8½	9	9 50	1,279,125
	{Pounds received	271,875	368,000	323,500		
August..... .. .	{Price	13	10	11	11 25	1,366,500
	{Pounds received	276,500	359,375	273,750		
September	{Price	14	10	11	11 25	1,042,625
	{Pounds received	242,250	304,000	204,500		
October..... .. .	{Price	14	11	12	12	1,186,500
	{Pounds received	202,875	329,250	223,250		
November... .. .	{Price	15	11½	12½	12 87½	856,875
	{Pounds received	214,000	206,750	191,250		
December..... .. .	{Price	13½	14	14	13 75	608,250
	{Pounds received.....	134,675	160,625	150,000		

SUMMARY OF TABLE.

The total pounds of best cheese received in four years was 13,930,800, of which 4,276,200 pounds was Eastern cheese. Amount realized therefrom, \$1,568,708. Average price best cheese for the four years 11.26 cents per pound.

THE PROCESS OF CHEESE MANUFACTURE.

The minute details of cheese making vary so greatly with different manipulators that in giving the description of the process only the fundamental principles can be outlined.

The evening's milk, received at the factory in a perfectly sweet and untainted condition, is run into the vats and cooled down to about 60 degrees, at which temperature it should be kept until morning. The morning's milk is added and the whole stirred thoroughly and heated to about 80 degrees (Instead of adding the morning's milk to the night's directly, the latter may be skimmed, then the morning's milk added and stirred. The cream thus obtained should be heated to about 80 degrees and the rennet stirred into it, the whole being then mixed with the milk in the vat in the usual manner).

The rennet is added (if Hansen's is used about $3\frac{1}{2}$ ozs. to 1,000 lbs. milk), and thoroughly mixed. Coagulation should take place in from 30 to 45 minutes.

After the curd is solid enough to retain its shape, when a cube three or four inches square is lifted, it is cut four times, twice with each knife at intervals of a few minutes to facilitate the separation of the whey. The curd is now gently stirred, care being taken to break as few cubes as possible, and the vat heated to 98 degrees, at which point it is held until the conditions necessary for the kind of cheese desired are reached. A short time (about an hour), gives a soft cheese, and a longer time (about one and one-half hours), gives a harder and firmer cheese. The curd is now agitated occasionally until the whey acquires a slight acidity, when it is run off and the curd immediately removed to the curd sink to drain and cool. Here is required the greatest nicety of manipulation, for upon the degree of acidity developed in the curd depends to a great extent the quality of the cheese. Heat develops acidity and cold retards it. If a greater degree is desired the curd should be heaped to retain heat, if a less degree spread the curd to cool it.

When the curd has become solid it is ground in the curd mill and salted to suit, say 2 or 3 lbs. salt to 100 lbs curd. The curd is now ready for

the press and should have a temperature of about 72 degrees F. Light pressure should be used at first and gradually increased to the proper amount, and the cheese should be left under pressure for two to three days.

The cheese is now ready for the curing room, where it is to remain until it has acquired the proper degree of ripeness. This part of the operation demands careful attention and delicate manipulation. The curing room should be double walled to assist in maintaining uniform temperature, light and airy. Some cheeses cure in six weeks and others require three months. The cheese should be turned and greased every day for the first month, about twice a week the second month, and at least one a week the third month.

Temperature is the great key to success in cheese making, as in the manufacture of all dairy products, and must be accurately observed, *guess work will not do.*

In no case should churning or separating be done while curd is setting, as it will prevent perfect coagulation.

FLOATING CURDS.

It is a well-known fact that it is an impossibility to make good cheese from a floating curd. The floating of curds is caused by the formation of gas in the small particles or cubes, which, by expansion, renders the curd lighter than its bulk of whey and it floats. Such curd contains the spores of a species of fungus, the presence of which may be attributed to various causes, prominent among which are unhealthy state of cows, cows drinking stagnant water or grazing on ground saturated with such water, cows being in heat or any nervous state which tends to raise the temperature of milk above normal (about 98 degrees) when drawn. Improper handling and ventilating milk are also potent factors in producing this bad state of the curd.

TREATMENT OF FLOATING CURDS.

As soon as the curd begins to float raise the temperature rapidly to 90 degrees F., draw off the whey and allow more acidity to develop in the curd.

Thoroughly ventilate, salt, press and treat in the usual manner. If, after placing in curing room, the cheese puffs out of shape, showing that fermentation has taken place, allow it to continue for a few days.

Pass through curd mill and expose to air for several hours, press, bandage and cure. No further trouble will occur, but the finished product will not be of the fine flavor so desirable, yet will be marketable.

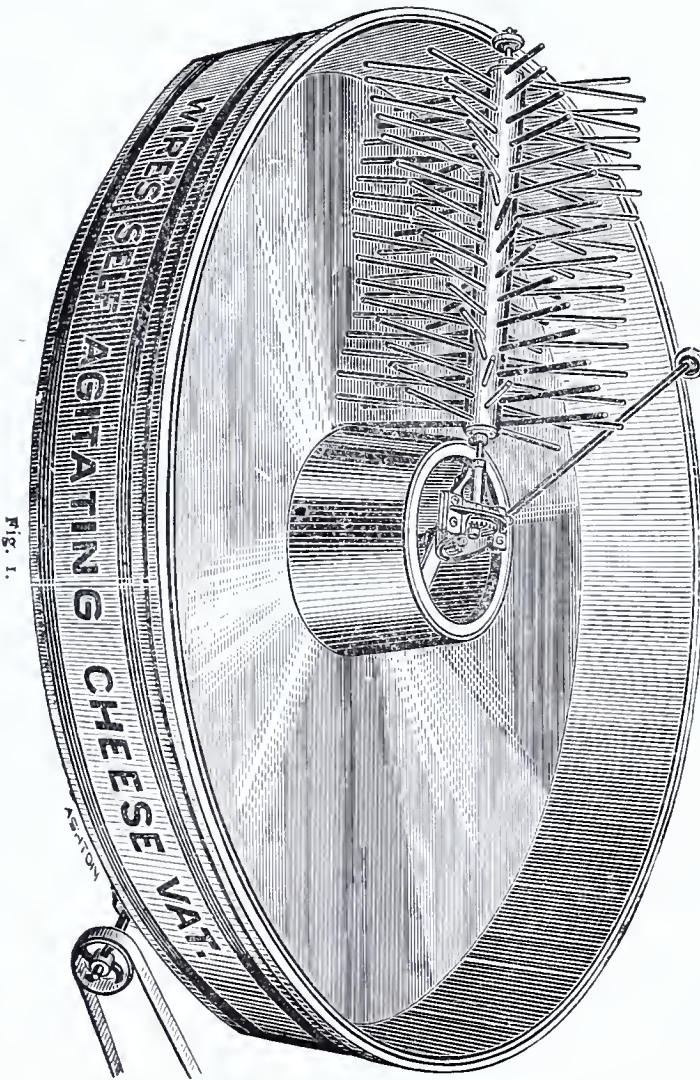
RENNET.

Rennet may be made from the calf's stomach if desired, but the liquid rennet extracts now on the market are much more convenient and are quite inexpensive, especially when purchased in bulk.

CHEESE MAKING APPARATUS.

There is a great variety of this apparatus on the market, all of which is well adapted to its special use. Those pieces needed for the successful manufacture of cheese, when the plant already contains the necessary outfit for butter making, are :

First—The cheese vats, several forms of which are here shown. The vat shown in figure 1 is claimed by the manufacturers, D. H. Roe & Co., Chicago, to do perfect work and save time and labor. The writer has never seen this vat in use so can not speak from experience concerning it.



Figures 2 and 3 show sectional views of the Curtis Improved Channel Bottom Vat, fitted to heat by steam. This vat is extensively used and gives great satisfaction.

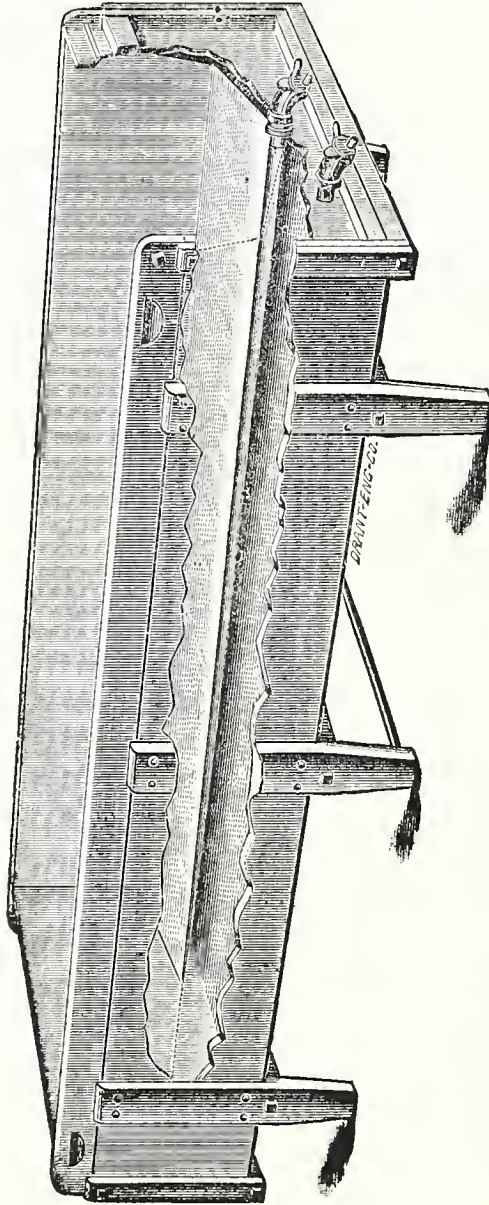


Fig. 2.

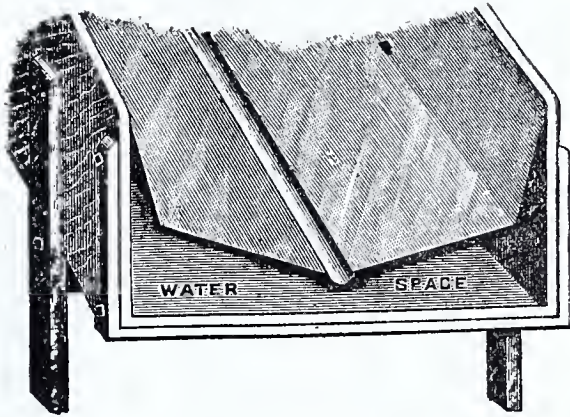


Fig. 3.

Figure 4 represents Roe's Union Vat, also fitted for steam heating, which is gaining a wide reputation as a servicable and practical vat for the factory. A great advantage of this vat is that it can be "knocked down" completely for shipment.

Fig. 4.

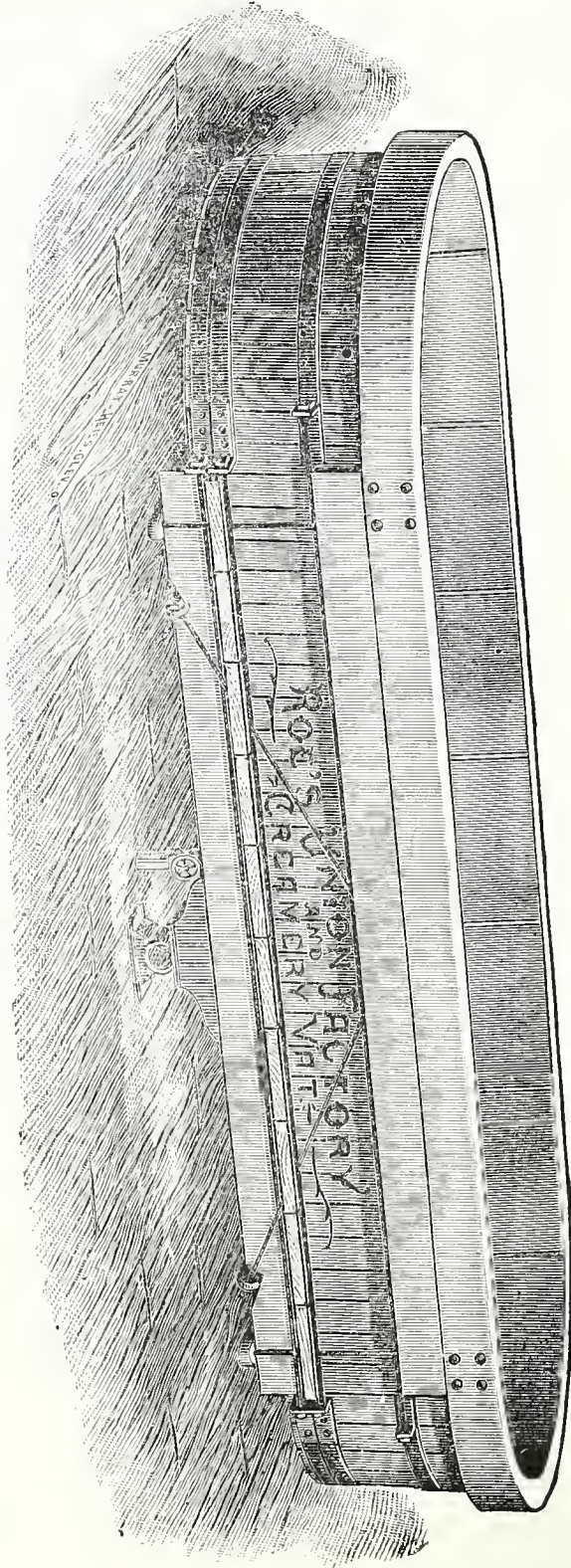


Figure 5 shows another form of Roe's Vats, somewhat similar to the Curtis Vat. Figure 6 shows the arrangement of the steam pipes in the vat, which insures a very even distribution of the heat in the milk vat, thus cooking the curd equally in all parts.

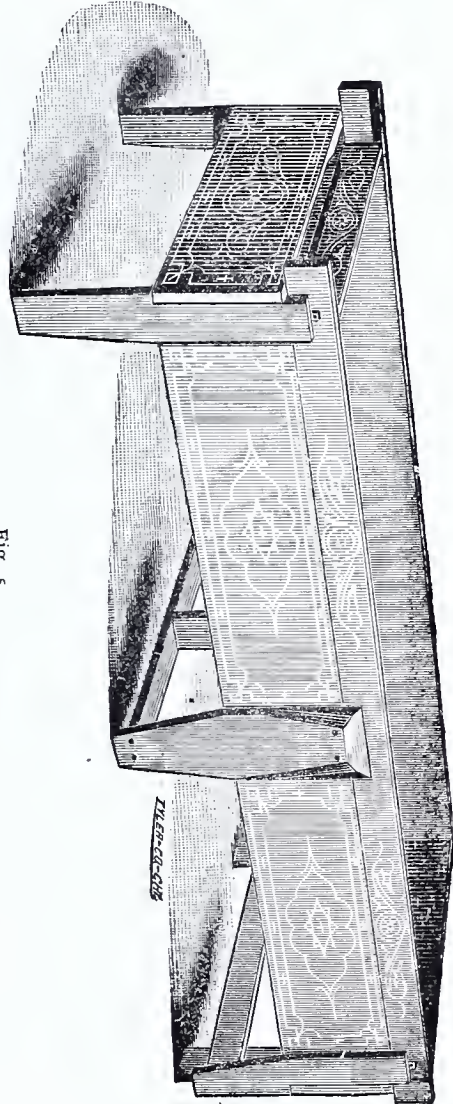


Fig. 5.



Fig. 6.

Figure 7 shows Roe's Cheese Vat, with heater combined. This heater consists of an outer shell of heavy galvanized iron and a fire box of heavy copper. This style of vat is suitable for dairy as well as for factory use.

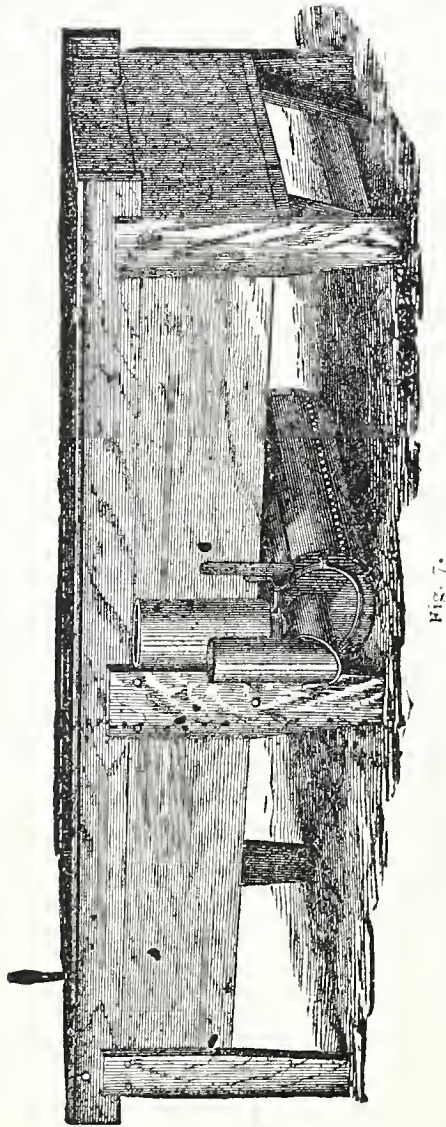


FIG. 7.

In figure 8 we have Roe's Farm Dairy Vat, which is complete in all respects and well adapted to the use for which it is made.

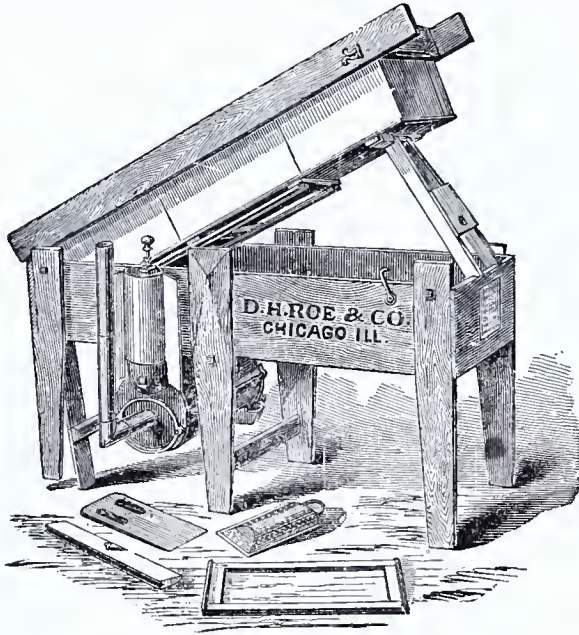


Fig. 8

Second—The curd knives. One horizontal and one perpendicular, shown in figures 9 and 10 respectively, for cutting the curd after coagulation to facilitate the whey separation.



Fig. 9.

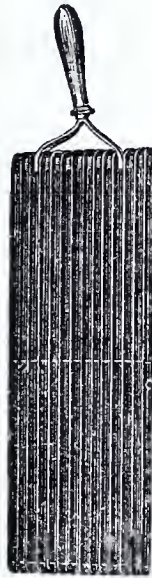


Fig. 10.

Third—The curd sink. This very necessary article for cooling and draining the curd is represented in figure 11. It is on casters and can be moved from place to place at will.

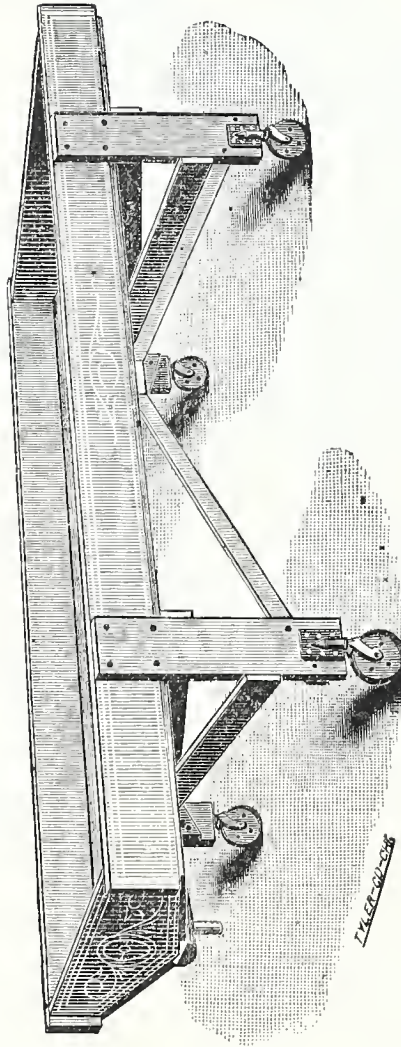


Fig. 11.

Fourth—The curd mill. This machine is used to break up the curds and assist in adding the salt. One of the different forms is shown in figure 12.

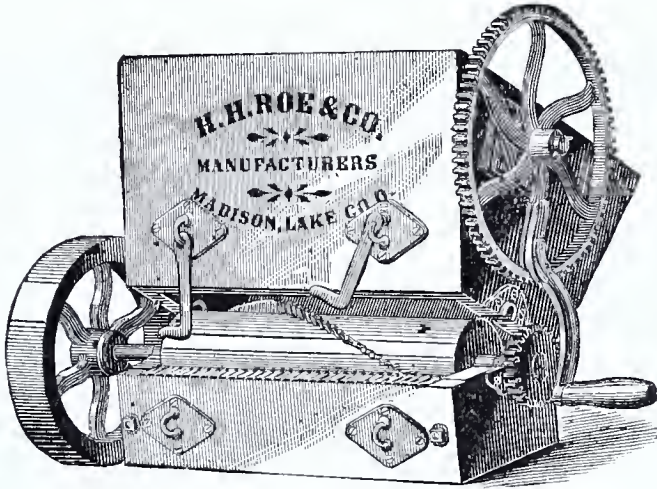


Fig. 12.

Fifth—The cheese press. The best form of press is that known as the Gang press, shown in figure 13. This press can be had single or double, pressing 20 and 40 cheeses at once. The double or "Combination" press may be had fitted for two sizes of cheeses if desired.

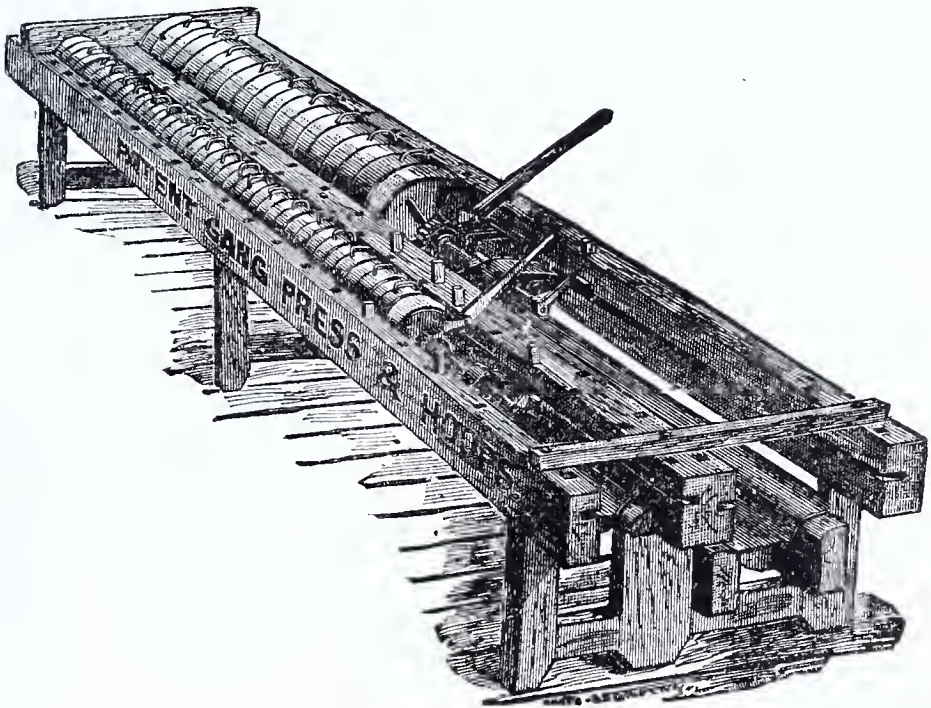


Fig. 13.

Figure 14 shows the upright press, which is adapted to both factory and private dairy.

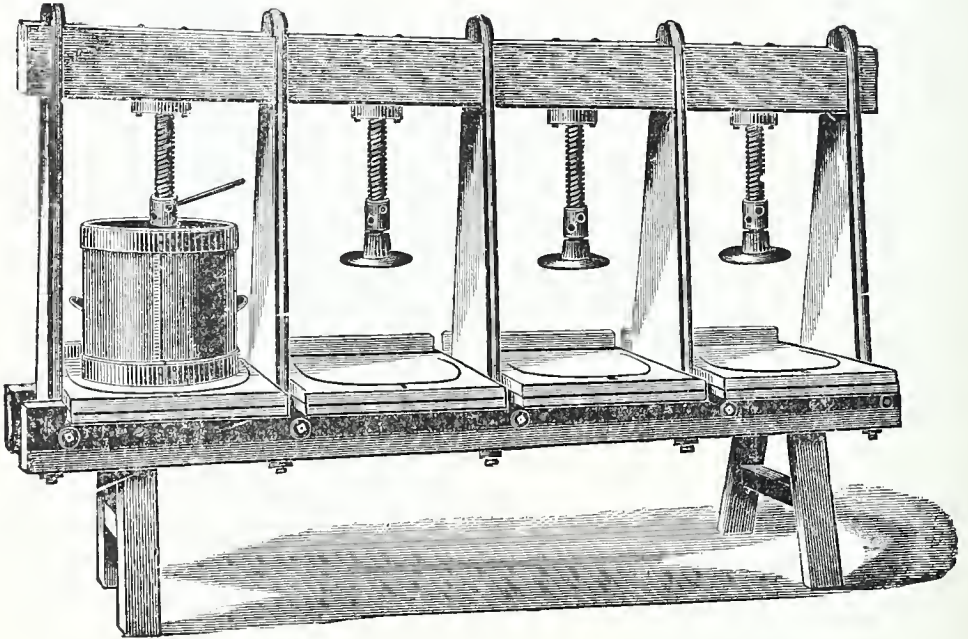


Fig. 14.

The hoops or moulds for cheese are best made of galvanized iron, as they do not swell, shrink nor absorb whey and are easily cleaned. The followers are usually of wood, and rubber rings are placed under them to prevent curd from pressing up.

Figure 15 shows the ordinary hoop and follower, and figure 16 shows the "expansion" hoop adjustable to fit any size cheese.

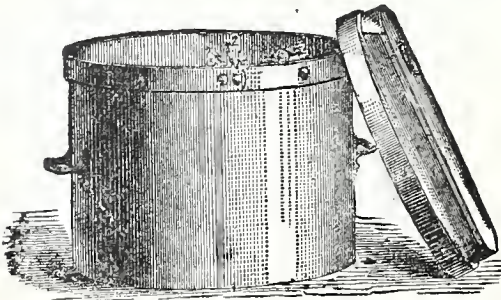


Fig. 15.

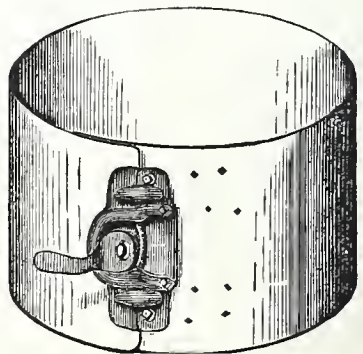


Fig. 16.

OUTFIT FOR A CHEESE FACTORY.

TO HANDLE THE MILK OF 400 COWS.

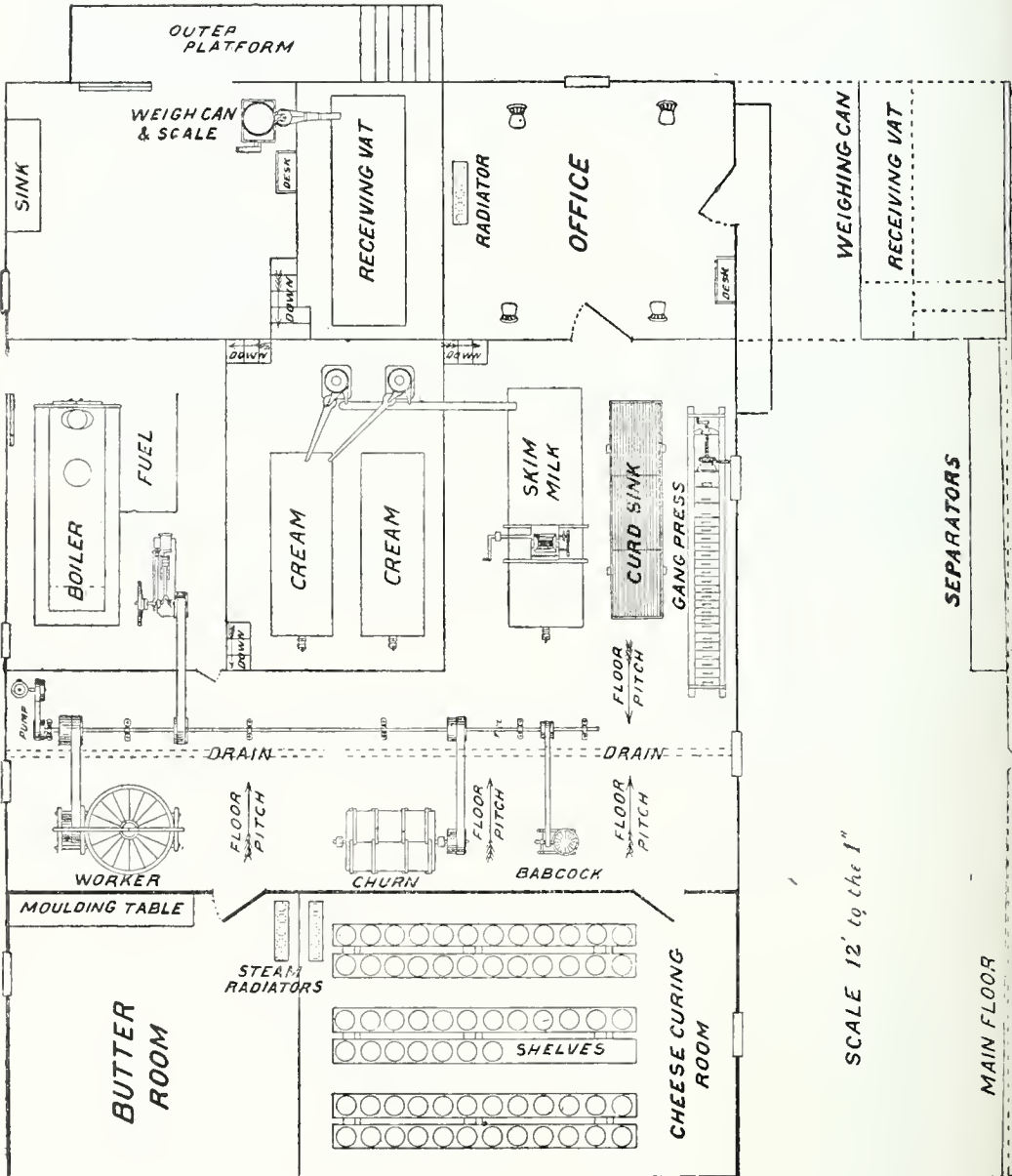
(*If not fitted to make butter.*)

- 1 6-h. p. boiler.
 - 2 600-gallon vats.
 - 2 Gang presses and Gang press hoops, or two upright presses with hoops and screws.
 - 1 600-pound platform scale, 5 beam.
 - 1 counter scale.
 - 1 60-gallon weigh can.
 - 1 conductor head and pipe.
 - 1 curd sink.
 - 1 curd mill.
 - 1 flat side curd pail.
 - 1 whey syphon and strainer.
 - 1 perpendicular curd knife.
 - 1 horizontal curd knife.
 - Dippers. thermometers and measuring glass, etc.
- If plant is fitted to make butter the boiler, scales and weigh can are not necessary.

ARRANGEMENT OF CHEESE FACTORY.

(*In connection with butter factory.*)

Through the kindness of G. G. Wickson & Co. of San Francisco we are permitted to present a very neat plan of arrangement for a butter and cheese making plant.



SCALE 12' to the 1"

MAIN FLOOR

* PAYING FOR MILK.

There are two methods by which milk can be paid for according to its content of butter fat. The first is on a basis of milk delivered without regard to the quantity of butter made from it ; the second is based upon the amount of butter made.

“Suppose, for instance, a creamery agrees to pay 80 cents per cwt. for milk containing 4 per cent. of butter fat, which means four pounds of fat in each hundred pounds of milk. This would be twenty cents for each pound of fat. Then a milk that contained five per cent. would be paid for at the rate of a dollar a hundred pounds, while only 70 cents a hundred would be paid for 3½ per cent. milk. The other method, paying according to the butter produced, is more complicated. It is done as follows : Multiply the per cent. of fat in each man's milk or cream by the number of hundred pounds he has delivered ; this gives the pounds of fat in the milk. The sum of the butter fat furnished by the several persons gives the whole amount that went in to make up the butter. The number of pounds of butter divided by the number of pounds of fat, gives the pounds of butter made from each pound of fat. This result multiplied by the pounds of fat furnished by a given patron gives the pounds of butter to be credited to the milk or cream delivered by that patron.”

“An example will make this clear.

A brings	645	pounds milk containing	4.20	per cent. fat
B “	389	“ “ “	4.75	“ “ “
C “	200	“ cream “	17.50	“ “ “

All the rest together bring 8,000 pounds of milk containing 4 per cent. fat.

A is credited with	6.45	by	4.20	=	26.09	pounds fat.
B “ “ “	3.89	by	4.75	=	18.48	“ “
C “ “ “	2.00	by	17.50	=	35.00	“ “
The rest are	80.00	by	4.00	=	320.00	“ “

The day's receipts are	399.57	“ “
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The butter maker finds he has made 420 pounds of butter ready for market.

420 divided by 399.57 = 1.05.

Each pound of fat has therefore made 1.05 pounds of butter.

A is credited with	26.09	by	1.05	=	27.39	pounds butter.
B “ “ “	18.49	by	1.05	=	19.41	“ “
C “ “ “	35.50	by	1.05	=	36.85	“ “
The rest are	320.00	by	1.05	=	336.00	“ “

419.65

*This article and the accompanying tables are reproduced from Bulletin No. 16 by request.

*Table for Facilitating Calculations when paying for milk on the basis of its fat contents.

Perct. fat.	PRICE OF MILK PER HUNDRED POUNDS.									
3.00	1.00	.97	.94	.91	.88	.86	.83	.81	.79	.77
3.10	1.03	1.00	.97	.94	.91	.89	.86	.84	.82	.79
3.20	1.07	1.03	1.00	.97	.94	.91	.89	.86	.85	.82
3.30	1.10	1.07	1.03	1.00	.97	.94	.92	.89	.87	.84
3.40	1.13	1.10	1.06	1.03	1.00	.97	.94	.92	.90	.87
3.50	1.17	1.13	1.09	1.06	1.03	1.00	.97	.95	.93	.89
3.60	1.20	1.16	1.12	1.09	1.06	1.03	1.00	.97	.95	.92
3.70	1.23	1.19	1.16	1.12	1.09	1.06	1.03	1.00	.98	.94
3.80	1.27	1.23	1.19	1.15	1.12	1.09	1.06	1.03	1.00	.97
3.90	1.30	1.26	1.22	1.18	1.15	1.11	1.08	1.06	1.03	1.00
4.00	1.33	1.29	1.25	1.21	1.18	1.14	1.11	1.08	1.06	1.02
4.10	1.37	1.32	1.28	1.24	1.21	1.17	1.14	1.11	1.08	1.05
4.20	1.40	1.35	1.31	1.27	1.24	1.20	1.17	1.14	1.11	1.07
4.30	1.43	1.39	1.34	1.30	1.26	1.23	1.19	1.17	1.14	1.10
4.40	1.47	1.42	1.38	1.33	1.29	1.26	1.22	1.19	1.16	1.12
4.50	1.50	1.45	1.41	1.36	1.32	1.29	1.25	1.22	1.19	1.15
4.60	1.53	1.48	1.44	1.39	1.35	1.31	1.28	1.25	1.21	1.17
4.70	1.57	1.52	1.47	1.42	1.38	1.34	1.31	1.28	1.24	1.20
4.80	1.60	1.55	1.50	1.45	1.41	1.37	1.33	1.30	1.27	1.23
4.90	1.63	1.58	1.53	1.48	1.44	1.40	1.36	1.33	1.29	1.25
5.00	1.67	1.61	1.56	1.52	1.47	1.43	1.39	1.36	1.32	1.28
5.10	1.70	1.65	1.59	1.55	1.50	1.46	1.42	1.39	1.35	1.30
5.20	1.73	1.68	1.63	1.58	1.53	1.49	1.44	1.41	1.37	1.33
5.30	1.77	1.71	1.66	1.61	1.56	1.51	1.47	1.44	1.40	1.35
5.40	1.80	1.74	1.69	1.64	1.59	1.54	1.50	1.47	1.42	1.38
5.50	1.83	1.77	1.72	1.67	1.62	1.57	1.53	1.50	1.45	1.41
5.60	1.87	1.81	1.75	1.70	1.65	1.60	1.56	1.52	1.48	1.44
5.70	1.90	1.84	1.78	1.73	1.68	1.63	1.58	1.55	1.50	1.46
5.80	1.93	1.87	1.81	1.76	1.71	1.66	1.61	1.57	1.53	1.49
5.90	1.97	1.90	1.84	1.79	1.74	1.69	1.64	1.60	1.56	1.51
6.00	2.00	1.94	1.88	1.82	1.76	1.71	1.67	1.62	1.58	1.54

From Bulletin 16, Vermont Experiment Station

Perct. fat.	PRICE OF MILK PER HUNDRED POUNDS									
3.00	.75	.73	.71	.70	.68	.67	.65	.64	.63	.61
3.10	.78	.75	.73	.72	.70	.69	.67	.66	.65	.63
3.20	.80	.78	.76	.75	.73	.71	.69	.68	.67	.65
3.30	.83	.80	.78	.77	.75	.74	.72	.70	.69	.67
3.40	.85	.83	.81	.79	.77	.76	.74	.73	.71	.69
3.50	.88	.85	.83	.82	.79	.78	.76	.75	.73	.71
3.60	.90	.88	.85	.84	.82	.80	.78	.77	.75	.73
3.70	.93	.90	.88	.86	.84	.83	.80	.79	.77	.75
3.80	.95	.93	.90	.89	.86	.85	.82	.81	.80	.77
3.90	.98	.95	.92	.91	.88	.87	.85	.83	.82	.79
4.00	1.00	.97	.95	.93	.91	.89	.87	.85	.84	.81
4.10	1.03	1.00	.97	.93	.93	.91	.89	.87	.86	.83
4.20	1.05	1.02	1.00	.98	.95	.94	.91	.90	.88	.85
4.30	1.08	1.05	1.02	1.00	.98	.96	.93	.92	.90	.88
4.40	1.10	1.07	1.05	1.02	1.00	.98	.95	.94	.92	.90
4.50	1.13	1.10	1.07	1.05	1.02	1.00	.97	.96	.94	.92
4.60	1.15	1.12	1.10	1.07	1.05	1.02	1.00	.98	.96	.94
4.70	1.18	1.15	1.12	1.09	1.07	1.04	1.02	1.00	.98	.96
4.80	1.20	1.17	1.14	1.12	1.09	1.07	1.04	1.02	1.00	.98
4.90	1.23	1.20	1.17	1.14	1.11	1.09	1.07	1.04	1.02	1.00
5.00	1.25	1.22	1.19	1.16	1.14	1.11	1.09	1.06	1.04	1.02
5.10	1.28	1.24	1.21	1.19	1.16	1.13	1.11	1.09	1.06	1.04
5.20	1.30	1.27	1.24	1.21	1.18	1.16	1.13	1.11	1.08	1.06
5.30	1.33	1.29	1.26	1.23	1.20	1.18	1.15	1.13	1.10	1.08
5.40	1.35	1.32	1.29	1.26	1.23	1.20	1.17	1.15	1.12	1.10
5.50	1.38	1.34	1.31	1.28	1.25	1.22	1.20	1.17	1.14	1.12
5.60	1.40	1.37	1.34	1.30	1.27	1.24	1.22	1.19	1.17	1.14
5.70	1.43	1.39	1.36	1.33	1.30	1.27	1.24	1.21	1.19	1.16
5.80	1.45	1.41	1.39	1.35	1.32	1.29	1.26	1.23	1.21	1.18
5.90	1.48	1.44	1.41	1.38	1.34	1.31	1.28	1.26	1.23	1.20
6.00	1.50	1.46	1.43	1.40	1.36	1.33	1.30	1.28	1.25	1.22

Perct. fat.	PRICE OF MILK PER HUNDRED POUNDS.										
3.00	.60	.59	.58	.57	.56	.55	.54	.53	.52	.51	.50
3.10	.62	.61	.60	.59	.58	.57	.56	.55	.54	.53	.52
3.20	.64	.63	.62	.61	.60	.59	.58	.57	.55	.54	.53
3.30	.66	.65	.64	.63	.62	.60	.59	.58	.57	.56	.55
3.40	.68	.67	.66	.65	.63	.62	.61	.60	.59	.58	.57
3.50	.70	.69	.68	.66	.65	.64	.63	.62	.61	.59	.58
3.60	.72	.71	.70	.68	.67	.66	.65	.64	.62	.61	.60
3.70	.74	.73	.71	.70	.69	.68	.67	.65	.64	.63	.62
3.80	.76	.75	.73	.72	.71	.70	.68	.67	.66	.65	.63
3.90	.78	.77	.75	.74	.73	.71	.70	.69	.67	.66	.65
4.00	.80	.79	.77	.76	.75	.73	.72	.71	.69	.68	.67
4.10	.82	.81	.79	.78	.76	.75	.74	.72	.71	.70	.68
4.20	.84	.83	.81	.80	.78	.77	.75	.74	.73	.71	.70
4.30	.86	.84	.83	.82	.80	.79	.77	.76	.74	.73	.72
4.40	.88	.86	.85	.83	.82	.80	.79	.78	.76	.75	.73
4.50	.90	.88	.87	.85	.84	.82	.81	.79	.79	.76	.75
4.60	.92	.90	.89	.87	.86	.84	.83	.81	.80	.78	.77
4.70	.94	.92	.91	.89	.88	.86	.84	.83	.81	.80	.78
4.80	.96	.94	.93	.91	.90	.88	.86	.85	.83	.81	.80
4.90	.98	.96	.94	.93	.91	.90	.88	.86	.85	.83	.82
5.00	1.00	.98	.96	.95	.93	.91	.90	.88	.87	.85	.83
5.10	1.02	1.00	.98	.96	.95	.93	.92	.90	.88	.86	.85
5.20	1.04	1.02	1.00	.93	.97	.95	.93	.92	.90	.88	.87
5.30	1.06	1.04	1.02	1.00	.99	.97	.95	.93	.92	.90	.88
5.40	1.08	1.06	1.04	1.02	1.00	.99	.97	.95	.93	.92	.90
5.50	1.10	1.08	1.06	1.04	1.02	1.00	.99	.97	.95	.93	.92
5.60	1.12	1.10	1.08	1.06	1.04	1.02	1.00	.98	.97	.95	.93
5.70	1.14	1.12	1.10	1.08	1.06	1.04	1.02	1.00	.98	.97	.95
5.80	1.16	1.14	1.12	1.09	1.07	1.05	1.04	1.02	1.00	.98	.97
5.90	1.18	1.16	1.13	1.11	1.09	1.07	1.05	1.04	1.02	1.00	.98
6.00	1.20	1.18	1.15	1.13	1.11	1.09	1.07	1.05	1.03	1.02	1.00

INSTRUCTIONS FOR USING THE TABLE.

1. Decide how much is to be paid for each pound of butter fat. Multiply this by 4 and the result will be the amount to be paid for each hundred pounds of 4 per cent. milk. Select the next nearest number to this in the horizontal column opposite 4.00 and the perpendicular column passing through the selected number will be the column to be used as long as that price is employed. Multiply the number of hundred pounds of milk furnished by each man by the number in the selected perpendicular column that is opposite the per cent. of fat found in his milk, and the result will be the amount due him for his milk.

Example. It is decided to pay 18 cents per pound for butter fat. $18 \text{ by } 4 = .72$. Then the man who furnishes 4 per cent. milk is to get .72 per hundred for it. Start at 4.00 on the left side of the table and move to the right until you reach .72. It will be found in a column beginning with .54 and ending with 1.07, which means that at the price of 18 cents per pound for butter fat, .54 per hundred is paid for 3.00 per cent. milk, etc.

A brings 645 pounds of milk containing 4.20 per cent. fat. The number opposite 4.20 in the selected column is .75. $.45 \text{ by } 75 = \$4.84$ due A for his milk.

E brings 600 pounds 3.65 per cent. milk. 3.65 is half way between 3.60 and 3.70 and hence the price is half way between .65 and .67, or 66.

$6.00 \text{ by } .66 = \$3.96$ due E.

F brings 425 pounds 5.93 per cent. milk. 5.93 is nearer 5.90 than 6.00. $4.25 \text{ by } 1.04 = \4.42 due F.

2. It is intended to pay the patrons whatever is received for the butter less a certain amount per pound for cost of making and marketing. Multiply each man's milk by the per cent. of fat it contains and the sum of the several products will be the total amount of fat contained in the day's milk. Divide the pounds of butter made from the milk by the pounds of fat it contained to find how much butter each pound of fat makes. Multiplying the amount to be paid for each pound of butter by this last result will give the amount to be paid for each pound of fat. Suppose the patrons furnish milk containing 400 pounds butter fat which makes 420 pounds butter, selling for 27 cents per pound, and 4 cents is to be deducted for expenses.

$27 - 4 = 23\text{c.}$ 420 divided by 400 = 1.05.

$23 \text{ by } 1.05 = 24.15\text{c.}$ to be paid for each pound fat. $24.15 \text{ by } 4 = 97\text{c.}$ to be paid per hundred for 4 per cent milk. Starting on the table at 4.00 and going to the right .97 is found in the column headed .73, which would then be used as before.

